EASTERN REGION TECHNICAL ATTACHMENT
No. 84-19
December 3, 1984

# USE OF MDR IN RAINFALL ESTIMATION

The use of radar MDR values in estimating rainfall amounts has proven to be an effective technique. It is sometimes the only information available on which the issuance of a flash flood watch or warning may be based. The estimation of rainfall from MDR has been automated in an AFOS application program "MDR" (Peroutka, 1983). This program reads seven hours of radar observations from the local database and produces three graphics: one-, three-, and six-hourly sums of MDR values or rainfall amounts. Convective and stratiform Z-R relations are provided along with the option for a user defined relation.

If the computation is made for rain from stratiform clouds, the rainfall rates specified in the NWS Radar Code User's Guide are used directly. The highest VIP level observed in a given MDR grid square is assigned to that square. In the case of convective rainfall, highest VIP level generally covers only a small portion of the grid square. Typical observed areal coverage of various VIP levels has been computed by Brandes (1973) and his study has been adapted to estimate the fractional coverage of the MDR grid square for each VIP level. The results are shown in the second column of Table 1. The third column shows the convective rainfall rate for each VIP level from the NWS Radar Code User's Guide. When fractional averages of column 2 are considered, the adjusted rainfall rate for the MDR grid box is reduced to the value in column 4. This is the convective rainfall rate used by the "MDR" program. The rainfall for any individual hour is computed by the average of the rate at the beginning of the hour and at the end of the hour. This provides some time smoothing of the precipitation.

Experience with the "MDR" program over the last year has shown that the convective estimates are generally twice as large as the observed rainfall amounts from first order observing stations. This may be caused by the higher precipitation amounts frequently missing the first order stations. If the more plentiful second order stations are examined, larger rainfall amounts are frequently observed which correspond well with the MDR convective estimates.

Table 1. VIP Fractional Coverage and Associated Rainfall Rates.

| VIP | Fractional Coverage of MDR Box | Standard Convective Rainfall Rate (inches) | Adjusted Rainfall Rate for MDR Box (inches) |
|---|---|---|---|
| 1 | 1.00 | 0.15 | 0.15 |
| 2 | 0.68 | 0.65 | 0.49 |
| 3 | 0.16 | 1.65 | 0.65 |
| 4 | 0.079 | 3.35 | 0.7844 |
| 5 | 0.031 | 5.8 | 0.8603 |
| 6 | 0.002 | 7.1 | 0.8629 |

An example (provided by WSFO CLE) of this is shown in a comparison of figures 1 and 2, which depict observed six hour rainfall amounts on 13 Aug. 1984 and the corresponding MDR estimate for this same time period. The rainfall analysis in figure 1 includes all reporting stations in Cuyahoga County, Ohio which includes Cleveland. The highest reported is 3.11 inches at a substation Brooklyn, Ohio, while only 2.26 inches is reported at the first order station, Cleveland. The outline of Cuyahoga County is indicated on figure 2 and contains the highest MDR estimate 3.2 inches, which corresponds well with the observed 3.11 inches at Brooklyn. Urban flooding was associated with this rainfall.

Another case is provided by the 24 hour rainfall ending the morning of 29 Nov. 1984. The convective MDR estimates are shown in figure 3; six hour rainfall estimates were added manually to produce the 24 hour totals of this figure. The observed 24 hour rainfall amounts from first order stations are shown in figure 4 with the analysis of the estimates from figure 3 superimposed. In this case, the 3.25 inch observed rainfall at Williamsport, PA, corresponded well with the MDR estimate. An estimate of 4.5 inches was located just north of Williamsport but could not be confirmed when second order stations were examined. The 4 inch MDR estimate in Maryland was close to a 3.6 inch observation from a second order station in Maryland.

There is a special class of storms that does not fit the usual 2:1 MDR/observed rainfall relationship. These are the quasi-barotropic, warm top, VIP ≤3 storms typified by the storms associated with the Connecticut floods of June 1982 and the New Jersey floods of April 1984. The first order station observed rainfall in these storms tend to show a 1:1 correspondence between MDR and gage precipitation.

MDR precipitation estimates for stratiform rainfall tend to follow the same 2:1 relationship with first order station observed rainfall; however, there can be deviations from this relationship because of embedded convection. The choice of Z/R relationship is critical in these cases.

Bob Davis, WSFO Pittsburgh, compared MDR, RADAP and gage precipitation in several events. He found that the MDR tended to overestimate the average gage precipitation by 300%-700%. RADAP estimates were within 15%-30% of the gage precipitation for the same events. This was to be expected for several reasons--

1. RADAP has a much finer time and space resolution.
2. MDR assigns the highest VIP level in a grid square to the entire large grid square. Even though space resolution is corrected for the fractional coverage of each VIP level, time resolution is not corrected. It is assumed that the VIP level for any grid square, at the beginning and end of an hour, adequately describes the entire hour.

The conclusion to be drawn is that RADAP does a very credible job of specifying average precipitation, in addition to maximum precipitation. Despite its relatively coarse resolution, MDR does a credible job of specifying the maximum precipitation within a grid square.

All offices (without RADAP) should continue to use the MDR program and gain experience with it. TDL is now developing a flash flood alert program that will compare flash flood guidance values to MDR specified precipitation and alert the forecaster as critical values are approached. We need to be thoroughly knowledgeable about the performance of MDR, in various weather situations, before the TDL program becomes available.

## REFERENCES

Brandes E.A., 1973: The Variation of Oklahoma Spring Rains as Revealed by Radar, Preprints. 8th AMS Conference Severe Local Storms, Denver, Colorado, 146-148.

Peroutka, M.R., 1983: MDR--Processing Manually Digitzied Radar Observations, NOAA, Eastern Region Computer Programs, NWS, ERCP No. 15, National Weather Service, Garden City, NY

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December 3, 1984

Attachments (Figures 1 through 4)

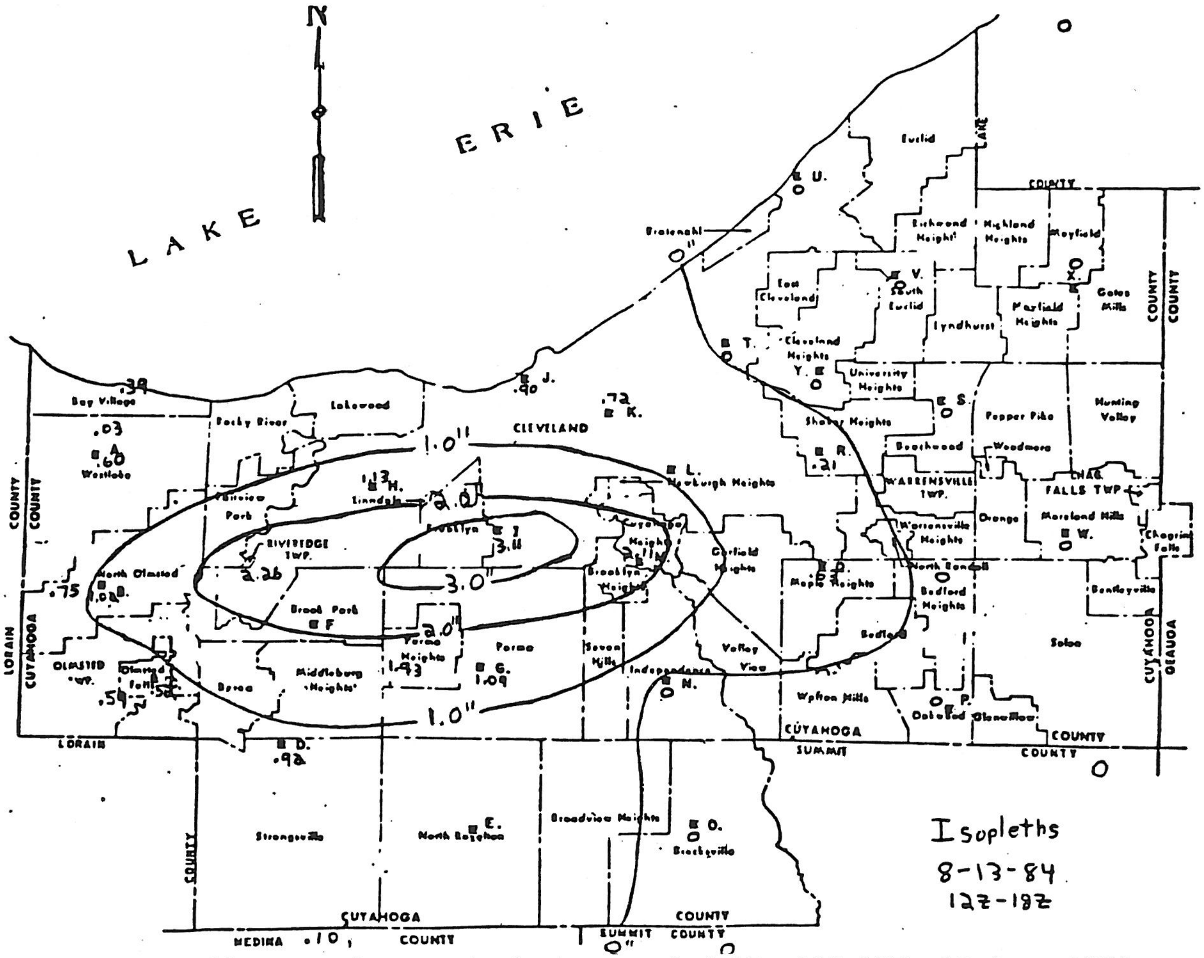

Fig. 1. Observed six hour rainfall, 12Z-18Z, 13 Aug. 1984.

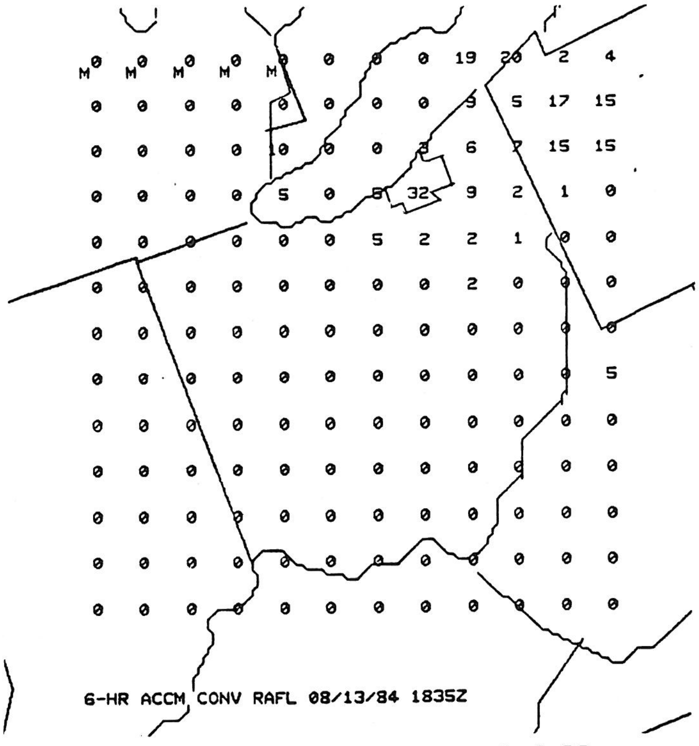

Fig. 2. MDR estimated 6 hour rainfall, 12Z-18Z, 13 Aug. 1984.

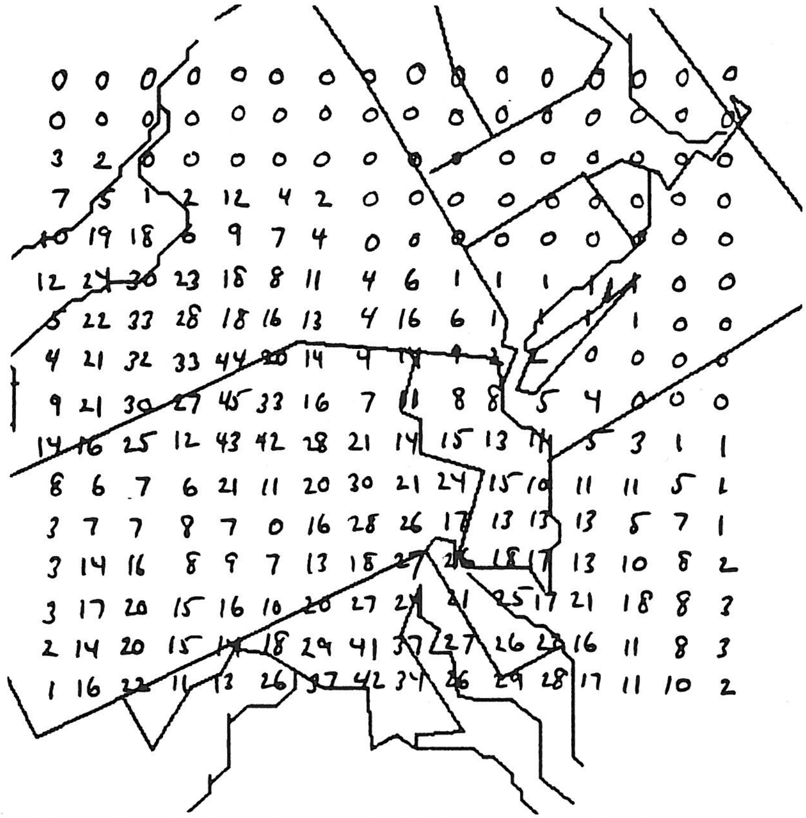

Fig. 3. MDR estimated 24 hour rainfall ending 12Z, 29 Nov. 1984.

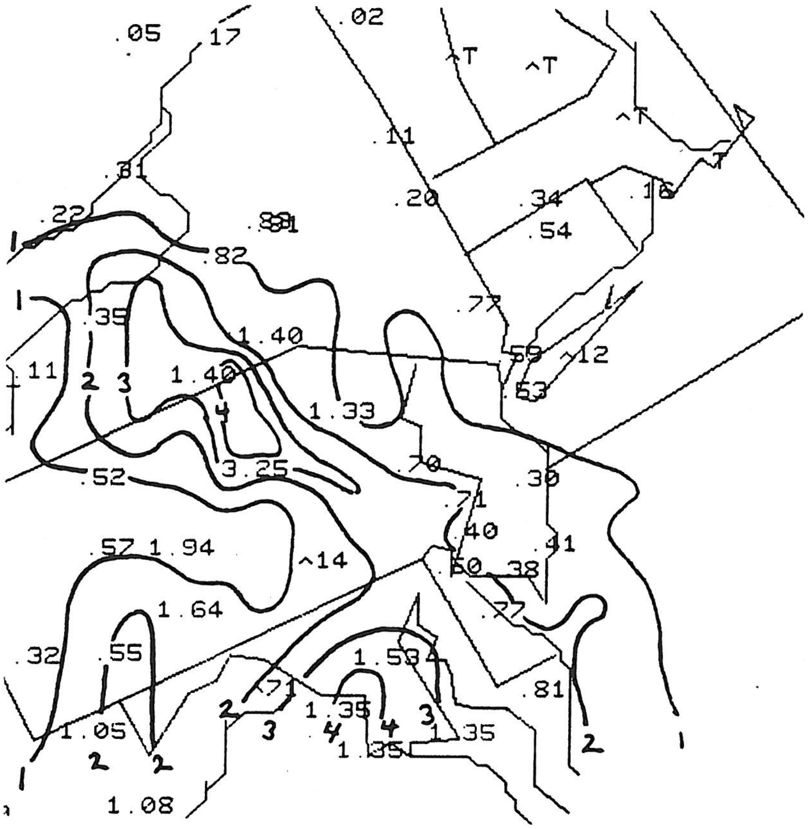

Fig. 4. Plot is observed first order station 24 hour rainfall ending 12Z, 29 Nov. 1984. Isopleths superimposed are the analysis of the MDR estimates in fig. 3 above.